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Fifth Biennial Report on Progress Toward Greenhouse Gas Reduction Goals

Maine Department of Environmental Protection

Report to the Joint Standing Committee on Environment and Natural Resources
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Fifth Biennial Report on Progress Toward Greenhouse Gas Reduction Goals

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Executive Summary

The Department of Environmental Protection (Department) is submitting this report to the Joint Standing Committee on Environment and Natural Resources pursuant to 38 M.R.S.A. § 578, which requires the Department to evaluate the State's progress toward meeting greenhouse gas (GHG) reduction goals established in P.L. 2003, ch. 237, and submit a report of its evaluation by January 1, 2006 and by that date every two years thereafter. This report summarizes the findings of the Department's fifth quantitative evaluation of Maine's progress towards meeting statutory GHG goals since the development of the original Climate Action Plan in 2004.

The Department's analysis of energy consumption, industrial processes, agriculture, and waste management for calendar years 2010 and 2011found that Maine is continuing in a downward trend in GHG emissions, putting the State on track to meet *Maine's Act to Provide Leadership in Addressing the Threat of Climate Change* medium-term goal of reducing GHG emissions to 10% less than 1990 levels by 2020. Gross statewide GHG emissions increased from 1990 until a peak in 2003, and have since steadily declined. This decrease is notable especially considering that a 900 megawatt nuclear electrical generation station ceased operations in 1996.

The Department's analysis indicates:

- 86% of GHG emissions in Maine are the result of energy consumption, largely produced by combustion of petroleum products; and emissions in this sector have been reduced by 6% since 2010.
- From 1990 to 2011 total energy consumption in Maine declined 10%, and total CO_2 emissions from that consumption declined 9.5%.
- The transportation sector produced an average of 40% of all CO_2 emissions in Maine between 1990 and 2011, and a total of 46% in each year from 2009–2011.
- CO_2 emissions from petroleum combustion in 2011 in the industrial sector, and the electric power sector dropped significantly over 1990 levels by 61% and 94% respectively.

New federal standards for vehicle fuel efficiency, electric generating facilities, and boilers are expected to reduce GHG emissions in the coming years. Additional GHG emission reductions can be achieved by encouraging energy efficiency strategies, substitution of petroleum products with renewable energy sources or lower emitting products such as natural gas, and discontinuing use of older more polluting fuel combustion units (e.g. automobiles, heating devices). The Department recommends that future GHG emission reduction programs in Maine focus on reducing petroleum consumption in the residential, commercial, and transportation sectors so that the State is able to meet 2020 reduction goals.

I. Introduction

In 2003, Maine's Act to Provide Leadership in Addressing the Threat of Climate Change (the "Act"), P.L. 2003, ch. 237, established greenhouse gas (GHG) reduction goals for 2010, 2020, and beyond. The Act set a goal for reduction of GHG emissions within the State, in the short term, to 1990 levels by January 1, 2010; to 10% less than 1990 levels by 2020; and to eliminate any dangerous threat to climate in the long-term (38 M.R.S.A. §576). 38 M.R.S.A. § 578 requires the Department to evaluate the State's progress toward meeting these reduction goals and submit a report of its evaluation by January 1, 2006 and by that date every two years thereafter. This report summarizes the findings of the Department's fifth quantitative evaluation of Maine's progress towards meeting statutory GHG goals since the development of the original Climate Action Plan in 2004.

In January 2012, the Department reported that Maine met the short-term goal of reducing GHG emissions to 1990 levels by 2010. Over this period, Maine's real GDP increased, while energy consumption and emissions declined. Analysis of data for the current report (i.e. calendar years 2010 and 2011) shows a continued downward trend in emissions (Appendix A). While a simple linear regression estimation of 2012 emissions indicates a slight increase in emissions in year 2012, it is important to note that this simple estimation in the previous future year estimate (2010) also showed a small increase which was subsequently determined as incorrect based on more recent data.

This inventory includes anthropogenic GHG emissions from within Maine using analytical methods that are consistent with the U.S. Environmental Protection Agency's (USEPA) national inventory development, and methods used by other New England states. The GHG's inventoried are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6). The Department conducted an extensive analysis of energy consumption information from the Department of Energy, and additionally utilized data from Maine's own reporting programs to estimate GHG emissions. The Department is continuing efforts to evaluate the impacts of land use and forestry on net GHG emissions, and to evaluate how many new federal emissions standards will affect future GHG emissions in Maine.

II. Methodology

Various methods can be used to develop emissions inventories including direct measurement from point sources and analysis of activity data. Activity data such as fuel use and industrial activity is more readily available and reliable than direct measurements from GHG emissions monitoring. The Department utilized the State Inventory Tool (SIT), a computer model developed by USEPA, augmented with data from state programs (e.g. point source emissions data, solid waste data) to estimate GHG emissions in Maine. The SIT was developed by USEPA to provide states with a comprehensive, standardized approach to estimating GHG emissions. This tool addresses the same sources that are in the National GHG inventory and it is based on the Intergovernmental Panel on Climate Change recommendations. Activity data is the driving force for emission estimation.

The tool contains default activity data while at the same time provides flexibility for states to input state specific data. GHG emissions are expressed in units of carbon dioxide (CO_2) or carbon dioxide equivalents (CO_2e). Gross carbon dioxide equivalent emissions for six

greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6) are calculated from activity data through the use of emissions factors. These emissions factors convert fuel use, energy generation and consumption, and other activity data into an equivalent CO_2 emission level expressed in metric tons. Emissions values in this report are expressed in Million Metric Tons of CO2 (MMTCO2) or Million Metric Tons of CO_2 Equivalent (MTCO2e). Fuel consumption values are expressed in British Thermal Units (Btu) or Billion British Thermal Units (BBtu).

The tool estimates GHG emissions from the following source categories:

- Energy
- Agriculture
- Industrial Processes
- Waste

The SIT is pre-populated with data from several federal agencies. The majority of the inventory data comes from the Department of Energy's Energy Information Administration (EIA). For many of the categories, this information is apportioned to the states from national and regional inventories. For this report, the Department performed a comprehensive analysis of the EIA and solid waste data provided in the tool, and updated it with information from Maine reporting programs. At the time of this report, EIA data was available through 2011. The Department extended estimates of Maine's GHG emissions to 2012 using the Microsoft Excel FORECAST function. In some cases input data was unavailable for year 2011 and these values are also estimated with the same method. These emissions estimates are color coded in red in the appendices.

Methods for inventory of GHG emissions from energy consumption is the subject of debate, but for the purposes of this report the Department included emissions that occur in Maine and applied EPA and Intergovernmental Panel on Climate Change methods for carbon accounting. In line with these methods, the Department accounted for CO_2 emissions from fossil fuel combustion and waste incineration at Maine's waste-to-energy facilities (Appendix B), and classified nuclear power and renewable resources as carbon neutral. Renewable resources include biofuel (mainly ethanol added to motor gasoline), biomass (wood, wood waste products including black liquor and sludge), hydroelectric, wind, solar, and geothermal. Therefore, CO_2 emissions from combustion of biomass and biofuel are not captured in the tool. CH_4 and N_2O emissions from stationary combustion of wood are captured and included in emissions totals. Information on energy consumption from renewable sources is also included in this report.

The EIA defines five sectors of energy consumption—electrical generators, industrial, commercial, residential, and transportation—to align with policies and programs for GHG emission reductions that target these sectors separately (Appendix C). In recognition that future efforts to reduce GHG emissions benefit from an understanding of the relative contribution of each sector, and how activities within those sectors impact their emissions, the Department evaluated energy consumption and associated GHG emissions using the same definitions.

The majority of CO_2 emissions from carbon emitting energy sources in Maine come from petroleum products. To better assess the consumption of various types of petroleum, these products were broken down into: motor gasoline; distillate fuel; petroleum coke; residual fuel; liquefied petroleum gas; jet fuel; kerosene, aviation gasoline; asphalt; and road oil and lubricants.

The Department did not estimate emissions or sequestration from Land Use, Land Use Change and Forestry (LULUCF) because EPA's State Inventory Tool does not provide an adequate estimation for the forest in New England. This is consistent with the approach taken by many New England states for developing GHG inventories at this time. LULUCF will be addressed in future inventories as the methodologies for estimating impacts from these activities improve.

During development of the *Third Biennial Report,* the Department questioned how much of the decline in GHG emissions in recent years was caused by economic recession. In the *Fourth Biennial Report*, the Department relied on the real Gross State Product (real GSP) to evaluate the impact of economic conditions on emissions. Starting with this report real GDP by state will be used in place of that metric which is outdated. Real GDP by state is the state counterpart of the Nation's gross domestic product (GDP), the most comprehensive measure of U.S. economic activity measured by the U.S. Bureau of Economic Analysis (BEA) [1] adjusted for inflation (or deflation).

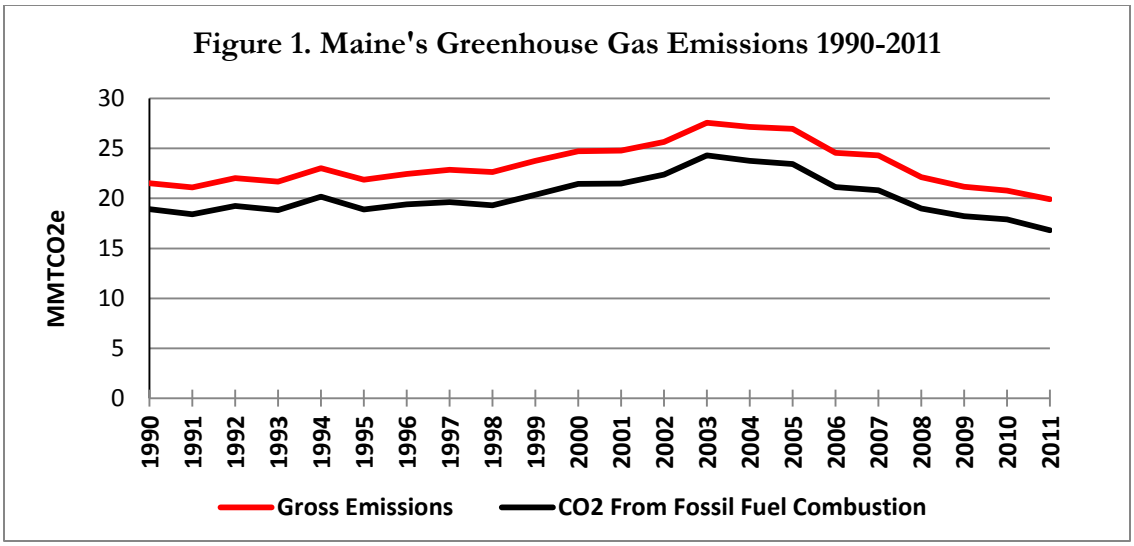
III. Results and Discussion

In the previous report, the Department concluded (based on analysis current to that date) that Maine met its goal of reducing emissions to 1990 levels by January 1, 2010. In our current analysis, based on revised data, Maine has still met this goal. Results of gross GHG emissions, emissions by source category, detailed estimates of energy consumption, and a simple economic analysis follow.

A. Gross GHG Emissions

Our current analysis utilizing data through the end of year 2011 indicates that Maine is continuing to realize a decline in GHG emissions from a peak nearly a decade ago (Figure 1). Total estimated GHG emissions in Maine increased from 21.53 million metric tons of carbon dioxide equivalents (MMTCO2e) in 1990 to a peak of 27.58 MMTCO2e in 2003, and then declined to 20.80 MMTCO2e in 2010. A complete analysis of Maine's GHG emissions by source for each year can be found in Appendix A.

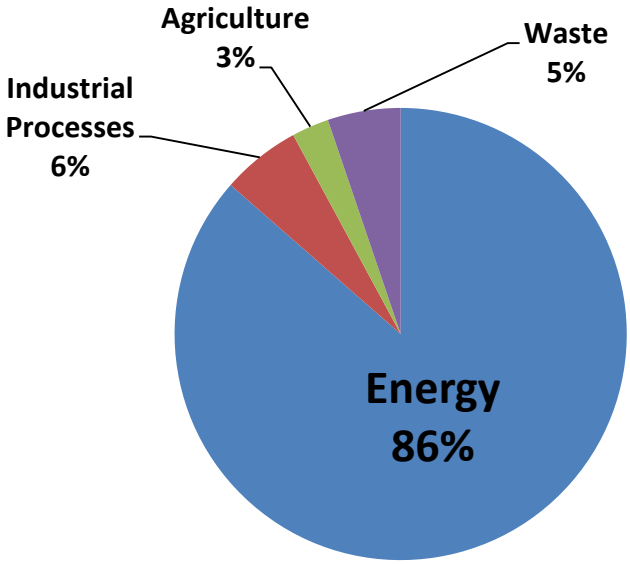
[1] http://www.bea.gov/newsreleases/regional/gdp_state/gsp_newsrelease.htm



Emissions due to energy consumption account for 86% of Maine's gross GHG emissions (Figure 2). Emissions from energy consumption include all of the CO_2 emissions from fossil fuel combustion, as well as CH_4 and N_2O. CO_2 emissions from the combustion of fossil fuels alone set the trend for the entire inventory.

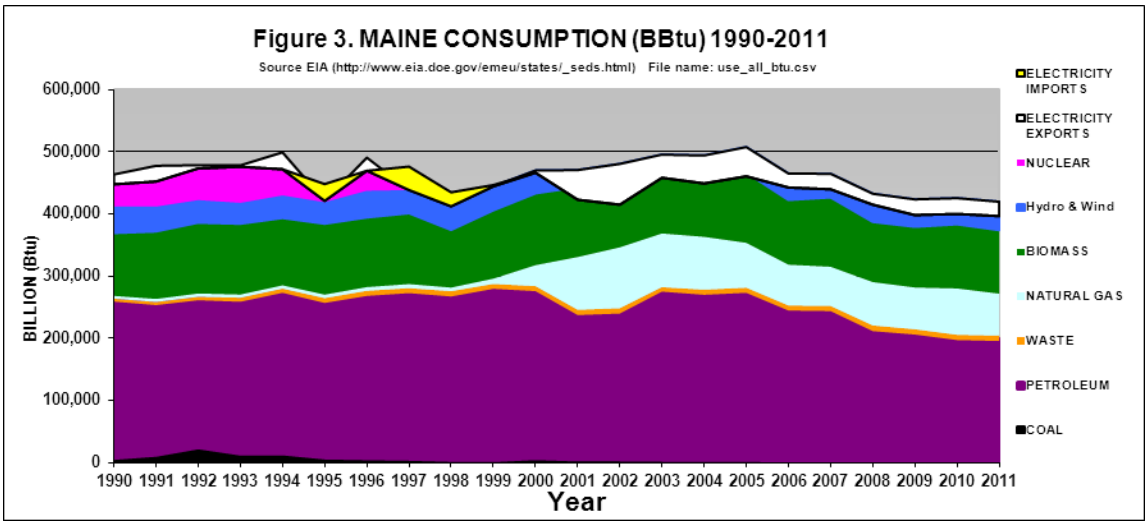
Although emissions of all other sectors are small in comparison, they still serve as indicators of progress toward mitigation goals. Emissions from industrial process, agriculture and waste categories combined in 2011 were 0.77 MMTCO2e above 1990 levels. However, emissions from each individual category have declined from peak levels which occurred between 2005–2007. The difference between the 2011 combined total versus the sum of the peak levels is 0.37 MMTCO2e.

Figure 2. 2011 Emissions by Source Category



B. Energy Consumption

Demand for, and consumption of energy, drive the vast majority of Maine's GHG emissions. From 1990 to 2011, total energy consumption in Maine declined 8% (Appendix D). Figure 3 illustrates the energy sources used to meet Maine's energy demands, including imported electricity following the closure of Maine's only nuclear power facility.

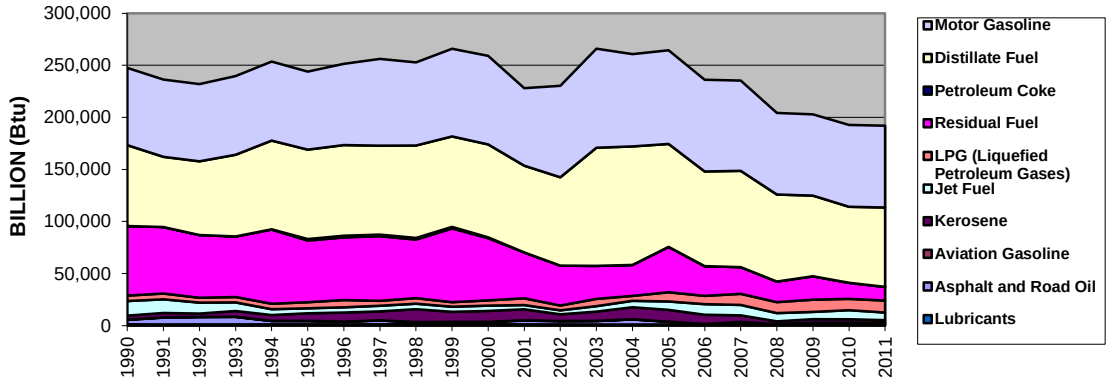


In 1990, 42% of Maine's energy was produced from carbon neutral sources. In 2011 this amount decreased to 36%. Much of this decrease was due to the decommissioning of Maine's only nuclear power plant. Although more energy consumed in Maine comes from carbon-emitting sources now than in 1990, CO_2 emissions continue to decline in large part because higher carbon emitting petroleum combustion has been offset with lower carbon emitting natural gas. In 2009 the total carbon neutral emissions were actually 2% lower than in 2011, indicating that the amount of energy from carbon neutral sources is actually increasing.

i. Petroleum Consumption

In 2011, Petroleum Products provided 48% of all energy consumed, and accounted for 86% of CO_2 emissions from carbon emitting energy sources. The residential, commercial, and transportation sectors are all predominately petroleum consumption based (Appendix E.3, E.4, E.5). Motor gasoline, distillate fuel and residual fuel account for 88% of all petroleum products consumed in 2011. While motor gasoline and distillate fuel consumption are near 1990 levels, residual fuel consumption has declined 80% since 1990. During this time period consumption of liquefied petroleum gas has doubled (Figure 4 and Appendix F).

Figure 4. Maine Petroleum Consumption 1990–2011

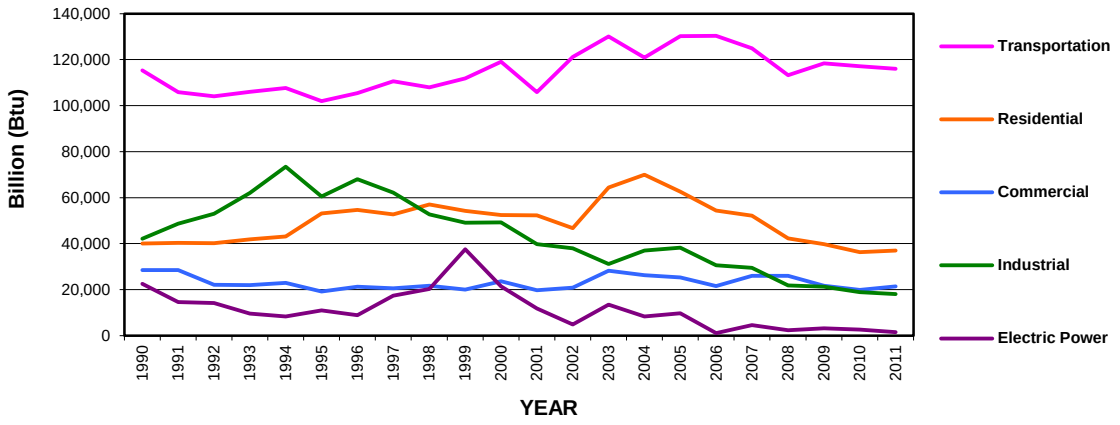


Source: EIA State Energy Data System (www.eia.doe.gov/emeu/states/_seds.html) File name: use_all_btu.csv

Emissions from petroleum combustion in all sectors have declined 5.95 MMTCO2 (69%) since 2003 (Appendix B). While the transportation sector has consistently maintained the highest consumption rates, averaging twice the amount of any other sector, the residential sector surpassed the industrial sector as the second largest consuming sector in 1998, a trend that continues through the analysis period (Figure 5). This can be explained in part by an increase in natural gas use in the industrial sector.

Figure 5. Maine Petroleum Consumption By Sector 1990–2011

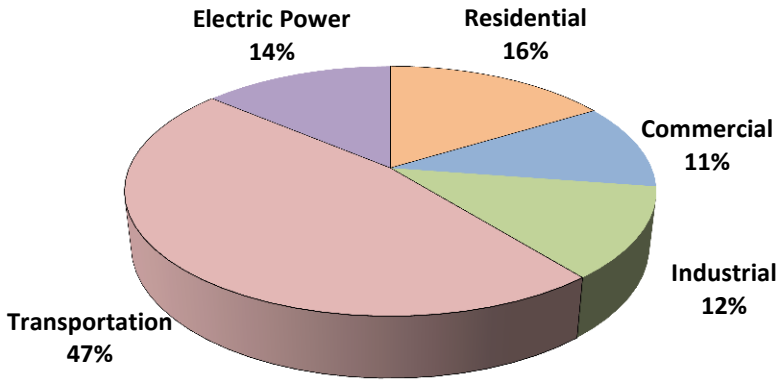
Source EIA (http://www.eia.doe.gov/emeu/states/_seds.html) File name: use_all_btu.csv



ii. Combustion CO_2 Emissions by Sector

Figure 6 illustrates the contribution of each sector to CO_2 emissions in 2011. The transportation sector produces almost half of all CO_2 emissions in Maine. The residential sector has the next highest emissions at 16%.

Figure 6. CO_2 Emissions from Combustion Sources by Sector in 2011



Electrical Generators

Maine's electric generating facilities consume energy to produce energy for other consumers. In 2011, Maine's electric utility generators emitted 2.56 $MMTCO_2$ from fossil fuels and waste (Appendix B). CO_2 emissions and energy consumption from petroleum combustion at electric generating facilities declined 93% since 1990. Nuclear, petroleum, and coal have been largely replaced with natural gas, biomass, and waste sources (Appendix E.1). Natural gas combustion accounts for 83% of the CO_2 emissions from this sector. Renewable resources (biomass, hydropower and wind) provided 73% of the energy consumed by these facilities in 2011. Additional information regarding CO_2 emissions from these facilities, as it relates to the Regional Greenhouse Gas Initiative, will be provided by the Efficiency Maine Trust in their annual report for that program.

Industrial

Maine's industrial sector emitted 2.03 MMTCO2 from fossil fuels in 2011. Although its use has declined, petroleum continues to be the largest source of CO_2 combustion emissions from the industrial sector. This sector obtained 66% of the energy it consumed from renewable resources, slightly more than in 1990 (Appendix E.2).

Commercial

The commercial sector emitted 2.06 MMTCO2 from fossil fuels and waste in 2011. An increase in the consumption of natural gas from 1990 to 2011 has contributed to an overall 11% reduction in CO_2 emissions from this sector over the same time period. Petroleum continues to account for a large percentage of CO_2 emissions in the sector at 73%. Most of the energy consumed by Maine's commercial sector is used for electricity and space heating. In 2011, Maine's waste-to-energy facilities provided 10% of the energy used by this sector (Appendices C and E.3).

Residential

In 2011, the residential sector emitted 2.74 MMTCO2 from fossil fuel consumption. This sector is highly dependent upon petroleum products, and significantly impacted by fuel price fluctuations. Petroleum accounts for 97% of all the CO_2 emissions from this sector.

Emissions from residential petroleum use peaked in 2004 at 5.13 MMTCO2 and steadily declined 48% by 2011. The mix of energy sources for the residential sector has changed little over the last two decades (Appendix E.4). This sector exceeds the commercial sector consumption of distillate and is the least served by natural gas.

Transportation

In 2011, the transportation sector emitted 7.9 MMTCO2 from fossil fuel combustion, 46% of total state CO_2 emissions (Appendix B). Petroleum accounts for 98% of the CO_2 emissions and 93% of the energy consumed by the transportation sector (Appendices C and E.5). The transportation sector consumed 7% more energy in 2011 than 1990, but total CO_2 emissions declined 5%. This reduction is attributed in part to the increased use of ethanol in this sector. Since biofuel is considered a renewable resource in this inventory, emissions from ethanol are omitted from emissions counts.

C. Economic Analysis

Maine's real GDP generally increased through the period of 1990 to 2011, suggesting that emissions reductions were not primarily related to economic activity. Since 1990, Maine's real GDP grew from $33.440 billion to $45.763 billion in 2011[2]. During the same period, energy consumption declined from 447,494 Billion Btu to 402,429 Billion Btu. From 1990 through 2000, greenhouse gas emissions continued to rise and track very closely with real GDP. However, beginning in 2004, GHG emissions began to decrease at an accelerating rate (Figure 7 and Appendix G).

Figure 7. Total Greenhouse Gas Emissions and Real Gross Domestic Product 1990–2011

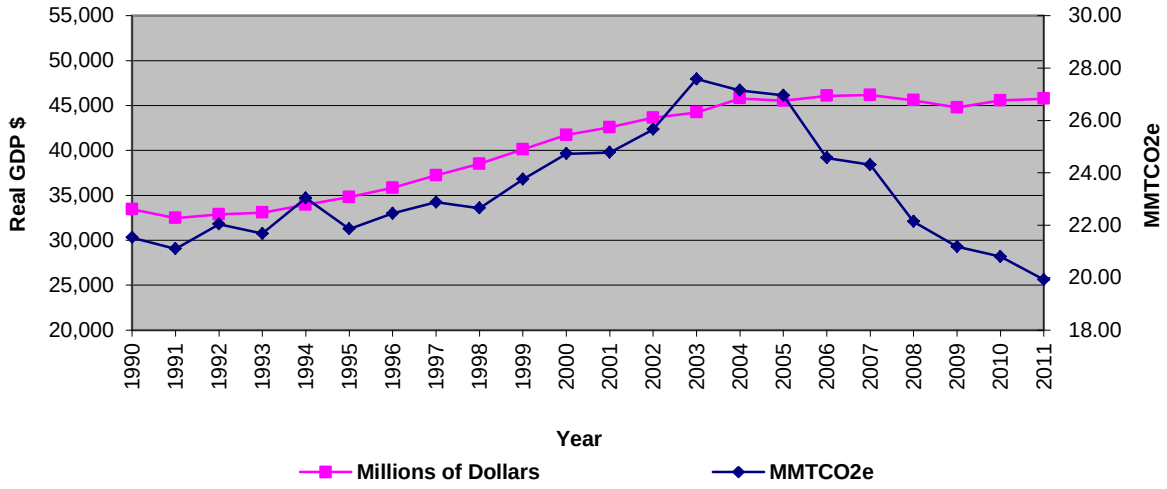
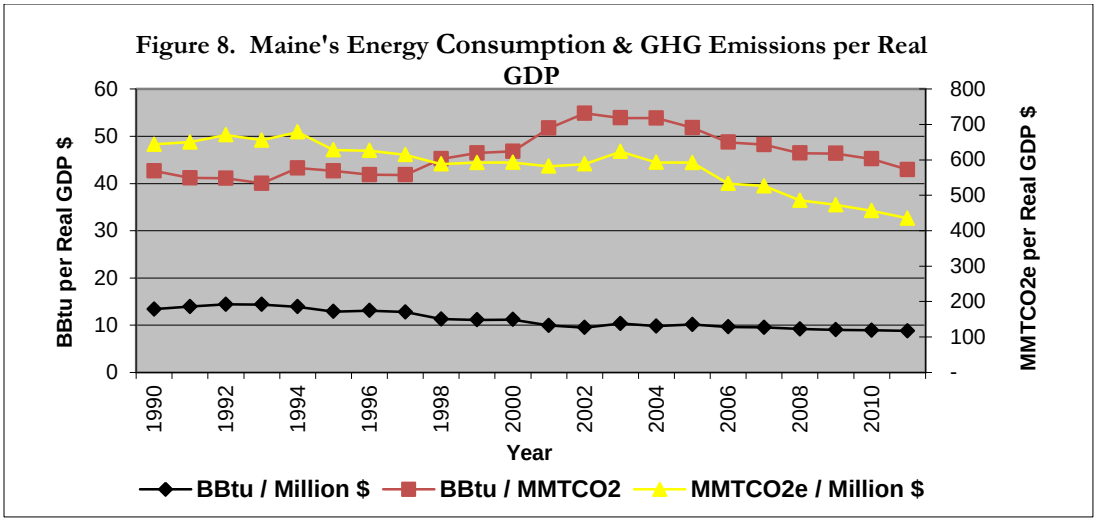


Figure 8 illustrates the relative stability of emissions per unit of heat input compared to the amount of energy consumed, and GHGs emitted per dollar of GDP, which have each declined. This could indicate that Maine is moving toward a more service-oriented economy or Maine's production of goods is becoming more energy efficient.

2 U.S. Bureau of Economic Analysis. Regional Data http://www.bea.gov/iTable/index_regional.cfm



IV. Conclusion

This *Fifth Biennial Report* on Maine's progress toward statutory GHG reduction targets provides an updated analysis of gross GHG emissions for the period of 1990-2012. The Department's analysis continues to indicate that Maine met the first statutory reduction target of reducing GHG emissions to 1990 levels by 2010. Gross GHG emissions by the end of year 2009 were only 0.93 MMTCO2e below the target (4.7%).

Preliminary estimates for 2012 suggest the downward trend may not be continuing but this estimate is based solely on linear regression over the time series. This method incorrectly resulted in a projected increase for 2010 in the last report.

Our current goal of decreasing emissions statewide to 10% less than 1990 levels by 2020 will be more easily met if the following Department recommendations are considered:

- Maine should continue to encourage replacement of petroleum products with carbon-neutral renewable energy sources and low carbon emitting natural gas, which effectively reduce GHG emissions in Maine and support economic growth; and
- Future policies and programs should focus on petroleum consumption in the residential, commercial, and transportation sectors including programs to provide assistance in the residential sector to decrease petroleum consumption.

The Department recognizes that estimating emissions using historic data trends can have limited value and is working to develop methods to improve these estimates. Recent year input data is difficult to find and compile for certain categories and sectors in time to include in this report. The Department recommends that the last two years of emissions data (i.e. 2011, 2012) be used with caution and that prior data (e.g. 2010 and earlier) is used with a greater level of confidence. Each year the Department revises these numbers with more recent data that has been quality assured and quality checked to a higher level of accuracy.

Appendix A

Maine's Greenhouse Gas - CO2e Emissions[3]

MMTCO2e

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy Total	19.60	19.13	19.98	19.57	20.93	19.63	20.14	20.39	20.02	21.11	22.18	22.18
CO_2 from Fossil Fuel Combustion	18.93	18.43	19.24	18.84	20.19	18.88	19.39	19.64	19.32	20.38	21.46	21.49
Stationary Combustion (CH_4 & N_2O)	0.26	0.28	0.29	0.29	0.28	0.29	0.29	0.28	0.24	0.27	0.28	0.27
Mobile Combustion (CH_4 & N_2O)	0.41	0.42	0.44	0.45	0.46	0.46	0.46	0.47	0.46	0.46	0.44	0.42
Industrial Processes Total	0.86	0.85	0.91	1.02	1.00	1.13	1.13	1.24	1.30	1.32	1.28	1.26
Agriculture Total	0.41	0.41	0.40	0.42	0.40	0.39	0.43	0.46	0.51	0.48	0.41	0.44
Enteric Fermentation	0.20	0.20	0.19	0.20	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18
Manure Management	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.08	0.10	0.11	0.06	0.06
Agriculture Soil Management	0.16	0.16	0.15	0.17	0.14	0.15	0.18	0.19	0.22	0.19	0.17	0.20
Burning of Agricultural Crop Waste	-	-	-	-	-	-	-	-	-	-	0.00	0.00
Waste Total	0.66	0.71	0.76	0.66	0.71	0.72	0.75	0.79	0.82	0.85	0.86	0.90
Municipal Solid Waste	0.54	0.60	0.64	0.54	0.60	0.60	0.63	0.67	0.70	0.73	0.74	0.78
Wastewater	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Gross Emissions	**21.53**	**21.10**	**22.04**	**21.68**	**23.04**	**21.86**	**22.45**	**22.88**	**22.65**	**23.75**	**24.73**	**24.78**

[3] Emission values in red indicate that the value is estimated using linear regression of the time series and not with the SIT tool due to a lack of data. Dashes indicate that the value was not calculated due lack of applicability or lack of data. Zero values indicate that based on the data available the Department estimates that there are no emissions from that particular source in Maine.

Appendix A. (continued)

MMTCO2e ESTIMATED

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Energy Total	23.01	24.90	24.33	24.02	21.68	21.33	19.42	18.67	18.33	17.22	**18.48**
CO_2 from Fossil Fuel Combustion	22.37	24.30	23.76	23.43	21.15	20.82	18.97	18.21	17.88	16.81	**18.07**
Stationary Combustion **(CH_4 & N_2O)**	0.25	0.24	0.25	0.29	0.26	0.28	0.25	0.30	0.29	0.29	**0.29**
Mobile Combustion **(CH_4 & N_2O)**	0.39	0.35	0.32	0.30	0.26	0.23	0.20	0.17	0.15	0.12	**0.12**
Industrial Processes Total	1.26	1.23	1.29	1.30	1.31	1.33	1.22	1.00	1.07	**1.13**	**1.11**
Agriculture Total	0.45	0.44	0.47	0.51	0.55	0.61	0.57	0.54	0.43	0.53	**0.54**
Enteric Fermentation	0.18	0.16	0.17	0.17	0.17	0.16	0.17	0.17	0.17	0.16	**0.16**
Manure Management	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.06	**0.06**
Agriculture Soil Management	0.20	0.21	0.24	0.28	0.33	0.39	0.34	0.30	0.20	0.31	**0.32**
Burning of Agricultural Crop Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Total	0.94	1.02	1.07	1.13	1.02	1.04	0.92	0.96	0.97	**1.04**	**1.05**
Municipal Solid Waste	0.82	0.89	0.94	1.01	0.90	0.92	0.80	0.84	0.84	0.91	**0.92**
Wastewater	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	**0.13**
Gross Emissions	**25.66**	**27.58**	**27.15**	**26.96**	**24.57**	**24.31**	**22.14**	**21.18**	**20.80**	**19.92**	**21.18**

Appendix B

Carbon Dioxide Emissions from Fossil Fuels and Waste incineration

MMTCO2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential Total	2.99	2.99	3.01	3.13	3.20	3.94	4.05	3.92	4.23	4.03	3.90
Coal	0.02	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	2.93	2.95	2.95	3.07	3.15	3.89	4.00	3.87	4.18	3.97	3.84
Natural Gas	0.03	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06
WASTE	-	-	-	-	-	-	-	-	-	-	-
Commercial Total	**2.31**	**2.27**	**1.87**	**1.85**	**1.89**	**1.60**	**1.76**	**1.74**	**1.82**	**1.72**	**2.01**
Coal	0.08	0.03	0.07	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Petroleum	2.06	2.08	1.60	1.59	1.66	1.39	1.53	1.49	1.57	1.45	1.71
Natural Gas	0.09	0.10	0.12	0.12	0.13	0.13	0.14	0.15	0.13	0.14	0.17
WASTE	0.08	0.06	0.08	0.09	0.09	0.08	0.08	0.10	0.11	0.13	0.12
Industrial Total	3.36	3.97	5.32	5.03	6.26	4.88	5.02	4.41	3.72	3.52	3.85
Coal	0.52	0.84	1.91	0.98	1.06	0.64	0.53	0.44	0.31	0.26	0.53
Petroleum	2.74	3.01	3.30	3.95	5.10	4.13	4.38	3.84	3.29	3.04	3.04
Natural Gas	0.11	0.12	0.11	0.09	0.09	0.11	0.12	0.13	0.12	0.22	0.29
WASTE	-	-	-	-	-	-	-	-	-	-	-
Transportation Total	8.29	7.59	7.48	7.61	7.72	7.31	7.55	7.93	7.74	8.00	8.58
Coal	-	-	-	-	-	-	-	-	-	-	-
Petroleum	8.29	7.59	7.48	7.61	7.71	7.30	7.55	7.92	7.74	8.00	8.53
Natural Gas	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.05
WASTE	-	-	-	-	-	-	-	-	-	-	-
Electric Power Total	**2.14**	**1.80**	**1.76**	**1.43**	**1.35**	**1.38**	**1.26**	**1.91**	**2.14**	**3.46**	**3.46**
Coal	0.36	0.57	0.57	0.58	0.57	0.37	0.38	0.39	0.35	0.36	0.39
Petroleum	1.69	1.09	1.07	0.72	0.63	0.86	0.71	1.34	1.57	2.85	1.63
Natural Gas	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.03	1.21
WASTE	0.09	0.12	0.11	0.12	0.14	0.15	0.17	0.17	0.22	0.22	0.23
GROSS CO_2 Emissions	**19.09**	**18.61**	**19.44**	**19.04**	**20.42**	**19.11**	**19.64**	**19.91**	**19.65**	**20.73**	**21.81**
Coal	0.98	1.44	2.57	1.63	1.65	1.02	0.92	0.84	0.68	0.63	0.93
Petroleum	17.71	16.72	16.39	16.94	18.26	17.56	18.17	18.46	18.34	19.31	18.75
Natural Gas	0.24	0.26	0.28	0.27	0.28	0.30	0.31	0.34	0.31	0.44	1.78
Waste	0.16	0.18	0.19	0.21	0.23	0.23	0.24	0.27	0.33	0.35	0.35

Appendix B. (continued)

MMTCO2	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential Total	**3.88**	**3.49**	**4.78**	**5.20**	**4.63**	**4.03**	**3.86**	**3.13**	**2.94**	**2.67**	**2.74**
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	3.82	3.43	4.71	5.13	4.57	3.97	3.79	3.06	2.87	2.60	2.66
Natural Gas	0.06	0.06	0.07	0.07	0.06	0.06	0.07	0.06	0.07	0.07	0.08
WASTE	-	-	-	-	-	-	-	-	-	-	-
Commercial Total	**1.71**	**1.95**	**2.49**	**2.32**	**2.26**	**1.97**	**2.33**	**2.36**	**2.01**	**1.91**	**2.06**
Coal	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Petroleum	1.42	1.52	2.04	1.90	1.82	1.54	1.84	1.85	1.51	1.39	1.50
Natural Gas	0.16	0.29	0.27	0.27	0.27	0.26	0.33	0.33	0.31	0.32	0.36
WASTE	0.12	0.14	0.18	0.15	0.17	0.17	0.16	0.18	0.20	0.20	0.20
Industrial Total	**3.80**	**3.75**	**3.19**	**3.45**	**3.66**	**3.34**	**2.98**	**2.66**	**2.33**	**2.14**	**2.03**
Coal	0.30	0.21	0.29	0.28	0.30	0.26	0.27	0.24	0.07	0.08	0.05
Petroleum	2.57	2.46	1.96	2.27	2.51	2.09	1.88	1.51	1.35	1.13	1.07
Natural Gas	0.85	1.00	0.93	0.85	0.81	0.95	0.78	0.87	0.86	0.89	0.87
WASTE	0.08	0.07	0.01	0.05	0.04	0.04	0.05	0.04	0.04	0.04	0.04
Transportation Total	**7.66**	**8.75**	**9.37**	**8.71**	**9.38**	**9.41**	**9.06**	**8.20**	**8.58**	**8.52**	**7.90**
Coal	-	-	-	-	-	-	-	-	-	-	-
Petroleum	7.59	8.70	9.32	8.67	9.35	9.39	9.02	8.15	8.54	8.42	7.76
Natural Gas	0.07	0.05	0.05	0.04	0.03	0.03	0.04	0.05	0.05	0.10	0.13
WASTE	-	-	-	-	-	-	-	-	-	-	-
Electric Power Total	**4.81**	**4.82**	**4.86**	**4.49**	**3.93**	**2.83**	**3.01**	**3.09**	**2.82**	**3.11**	**2.56**
Coal	0.43	0.53	0.40	0.40	0.35	0.35	0.33	0.30	0.08	0.13	0.09
Petroleum	0.88	0.36	1.01	0.62	0.73	0.08	0.34	0.17	0.24	0.19	0.11
Natural Gas	3.33	3.77	3.25	3.26	2.62	2.17	2.12	2.36	2.26	2.55	2.13
WASTE	0.17	0.17	0.20	0.20	0.23	0.23	0.22	0.25	0.25	0.23	0.23
GROSS CO2 Emissions	**21.86**	**22.75**	**24.68**	**24.17**	**23.87**	**21.59**	**21.24**	**19.44**	**18.69**	**18.35**	**17.28**
Coal	0.73	0.74	0.70	0.68	0.66	0.62	0.61	0.55	0.15	0.21	0.14
Petroleum	16.28	16.47	19.05	18.60	18.98	17.07	16.87	14.74	14.51	13.74	13.10
Natural Gas	4.47	5.16	4.55	4.48	3.80	3.47	3.33	3.68	3.54	3.93	3.57
Waste	0.37	0.38	0.38	0.40	0.44	0.44	0.42	0.47	0.48	0.47	0.47

Appendix C.

Sector Definitions[4]

- **Electric Power Sector:** An energy-consuming sector that consists of electricity-only and combined-heat-and-power plants within the NAICS (North American Industry Classification System) 22 category whose primary business is to sell electricity, or electricity and heat, to the public. *Note: This sector includes electric utilities and independent power producers.*

- **Industrial Sector:** An energy-consuming sector that consists of all facilities and equipment used for producing, processing, or assembling goods. The industrial sector encompasses the following types of activity: manufacturing (NAICS codes 31–33); agriculture, forestry, fishing and hunting (NAICS code 11); mining, including oil and gas extraction (NAICS code 21); and construction (NAICS code 23). Overall energy use in this sector is largely for process heat and cooling and powering machinery, with lesser amounts used for facility heating, air conditioning, and lighting. Fossil fuels are also used as raw material inputs to manufactured products. *Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the above-mentioned industrial activities.*

- **Commercial Sector:** An energy-consuming sector that consists of service-providing facilities and equipment of: businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters. It also includes sewage treatment facilities. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a wide variety of other equipment. *Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the activities of the above-mentioned commercial establishments.*

- **Residential Sector:** An energy-consuming sector that consists of living quarters for private households. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. The residential sector excludes institutional living quarters.

- **Transportation Sector:** An energy-consuming sector that consists of all vehicles whose primary purpose is transporting people and/or goods from one physical location to another. Included are automobiles; trucks; buses; motorcycles; trains, subways, and other rail vehicles; aircraft; and ships, barges, and other waterborne vehicles. Vehicles whose primary purpose is not transportation (e.g., construction cranes and bulldozers, farming vehicles, and warehouse tractors and forklifts) are classified in the sector of their primary use. In this report, natural gas used in the operation of natural gas pipelines is included in the transportation sector.

[4] **Source: EIA State Energy Data System (www.eia.doe.gov/emeu/states/_seds.html)**

Appendix D.

Maine Energy Consumption[5]

COAL

BILLION (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	214	9	7	5	6	6	6	0	0	0	0
Commercial	858	69	44	45	70	65	57	0	0	0	0
Industrial	5,533	5,687	3,115	2,973	3,219	2,780	2,937	2,633	797	862	573
Electric Power	3,808	4,216	4,315	4,312	3,764	3,767	3,583	3,275	856	1,418	969
Transportation	-	-	-	-	-	-	-	-	-	-	-
COAL	**10,413**	**9,980**	**7,481**	**7,336**	**7,059**	**6,618**	**6,583**	**5,908**	**1,652**	**2,280**	**1,542**

PETROLEUM

BILLION (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	40,001	52,406	64,443	69,934	62,561	54,328	52,091	42,291	39,754	36,211	36,921
Commercial	28,516	23,632	28,230	26,232	25,332	21,552	26,023	25,918	21,632	19,803	21,358
Industrial	42,109	49,218	31,169	37,011	38,201	30,622	29,484	21,770	21,225	18,874	18,093
Electric Power	22,503	21,414	13,442	8,307	9,708	1,093	4,535	2,329	3,156	2,591	1,516
Transportation	115,381	119,076	130,091	120,922	130,182	130,282	124,871	113,172	118,384	117,196	115,972
PETROLEUM	**248,510**	**265,746**	**267,375**	**262,406**	**265,985**	**237,877**	**237,005**	**205,480**	**204,151**	**194,676**	**193,861**

NATURAL GAS

BILLION (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	651	1195	1,266	1,238	1,204	1,038	1,253	1,174	1,341	1,282	1,467
Commercial	1,686	31,94	5,000	5,012	5,019	4,954	6,157	6,270	5,778	6,055	6,866
Industrial	2,034	5,576	17,950	16,496	15,804	18,260	14,942	16,646	16,530	17,150	16,636
Electric Power	196	22,889	61,280	61,515	49,514	40,944	39,982	44,611	42,618	48,137	40,122
Transportation	5	932	898	685	612	520	806	1,007	873	1,821	2,499
NATURAL GAS	**4,572**	**33,785**	**86,394**	**84,946**	**72,153**	**65,716**	**63,140**	**69,708**	**67,140**	**74,445**	**67,589**

BIOFUELS

BILLION (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	1	2	5	11	14	17
Industrial	0	0	0	0	0	0	0	0	0	0	0
Electric Power	0	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	375	551	789	4,054	5,154	5,859	5,983
BIOFUELS	**0**	**0**	**0**	**0**	**375**	**552**	**791**	**4,059**	**5,165**	**5873**	**6,000**

[5] **Source: EIA State Energy Data System (www.eia.doe.gov/emeu/states/_seds.html)**

Appendix D. (continued)

WASTE

BILLION (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	0	0	0	0	0	0	0	0	0	0	0
Commercial	2,177	2,757	3,309	3,113	3,169	3,076	3,088	3,452	3,501	3,680	3,661
Industrial	0	0	115	1,062	828	746	984	845	701	710	730
Electric Power	2,459	5,321	3,835	4,223	4,244	4,327	4,242	4,874	4,402	4,212	4,368
Transportation	-	-	-	-	-	-	-	-	-	-	-
WASTE	**4,636**	**8,078**	**7,259**	**8,397**	**8,241**	**8,149**	**8,314**	**9,171**	**8,604**	**8,602**	**8,758**

BIOMASS

BILLION (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	4,292	3,474	3,068	3,145	6,037	5,354	5,918	6,622	14,290	12,476	12,760
Commercial	933	751	541	529	969	899	980	1,015	2,038	1,993	1,942
Industrial	76,963	90,083	62,535	63,707	66,375	59,496	66,270	57,568	53,863	59,168	61,900
Electric Power	19,040	21,136	28,531	29,083	39,682	38,333	38,345	31,666	27,548	29,623	25,574
Transportation	-	-	-	-	-	-	-	-	-	-	-
BIOMASS	**101,227**	**115,444**	**94,676**	**96,464**	**113,062**	**104,082**	**111,513**	**96,870**	**97,739**	**103,260**	**102,176**

HYDRO & WIND

BILLION (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0
Industrial	13,982	13,221	10,353	5,641	6,250	7,725	6,863	7,509	7,391	6,883	7,269
Electric Power	28,568	23,409	21,770	28,717	34,655	34,710	31,064	37,711	36,630	35,161	38,257
Transportation	0	0	0	0	0	0	0	0	0	0	0
HYDRO & WIND	**42,550**	**36,630**	**32,123**	**34,358**	**40,905**	**42,435**	**37,927**	**45,220**	**44,021**	**42,044**	**45,526**

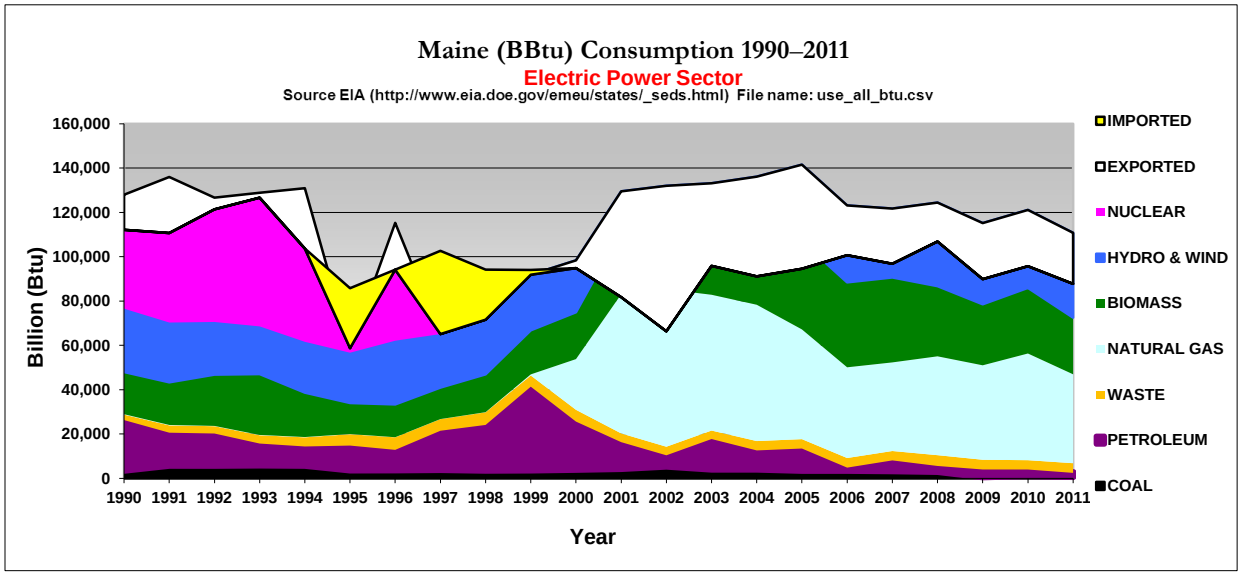
ALL SECTORS

BILLION (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
COAL	10,413	9,980	7,481	7,336	7,059	6,618	6,583	5,908	1,652	2,280	1,542
PETROLEUM	248,510	265,746	267,375	262,406	265,985	237,877	237,005	205,480	204,151	194,676	193,861
NATURAL GAS	4,572	33,785	86,394	84,946	72,153	65,716	63,140	69,708	67,140	74,445	67,589
BIOFUELS	0	0	0	0	375	552	791	4,059	5,165	5,873	6,000
WASTE	4,636	8,078	7,259	8,397	8,241	8,149	8,314	9,171	8,604	8,602	8,758
BIOMASS	101,227	115,444	94,676	96,464	113,062	104,082	111,513	96,870	97,739	103,260	102,176
NUCLEAR	51,436	0	0	0	0	0	0	0	0	0	0
Hydro & Wind	42,550	36,630	32,123	34,358	40,905	42,435	37,927	45,220	44,021	42,044	45,526
TOTAL	463,345	469,664	495,307	493,907	507,782	465,429	465,272	436,416	428,472	431,180	425,452
ELECTRICITY	-15,851	-3,509	-37,279	-45,003	-46,976	-22,465	-24902	-17,580	-25,309	-25,394	-23,023
TOTAL net Electricity	**447,494**	**466,155**	**458,028**	**448,904**	**460,806**	**442,964**	**440,370**	**418,836**	**403,163**	**405,786**	**402,429**
ELECTRICITY EXPORT (zero Imports)	-15,851	-3509	-37,279	-45,003	-46,976	-22,465	-24902	-17580	-25309	-25394	-23023

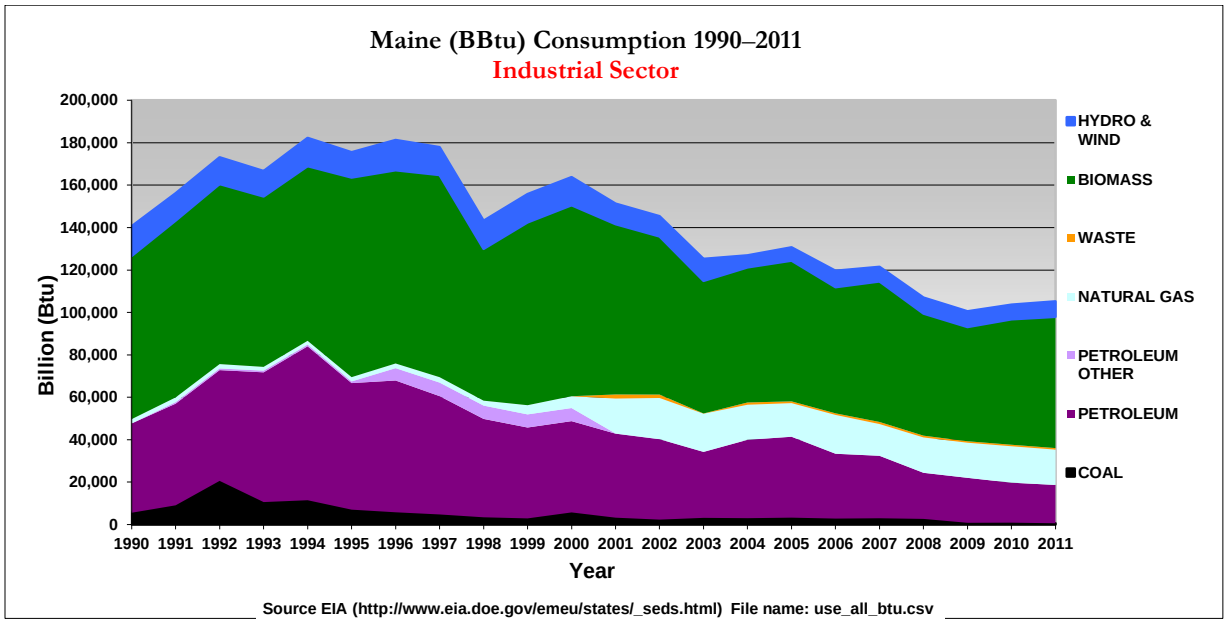
Appendix E.

Sector Consumption Graphs

E.1. Electric Power

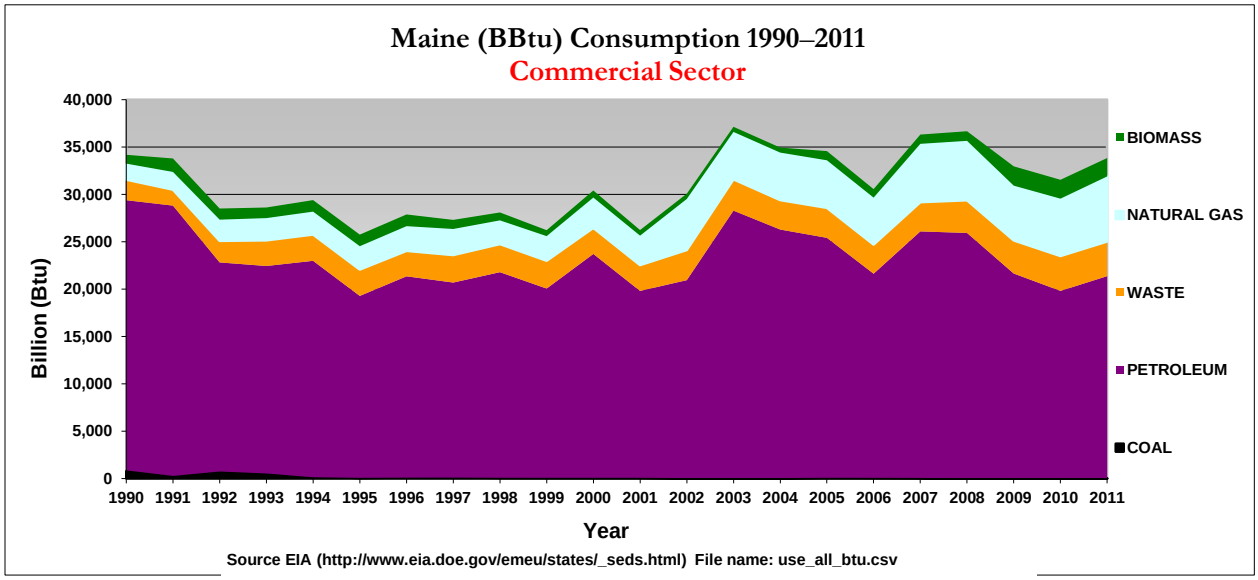


E.2. Industrial

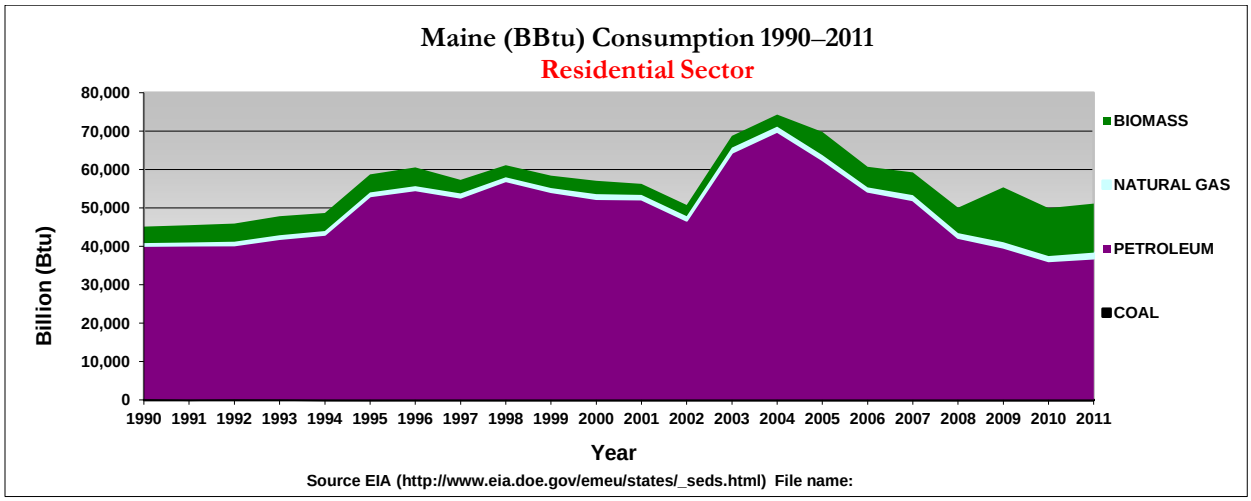


Appendix E. (continued)

E.3. Commercial

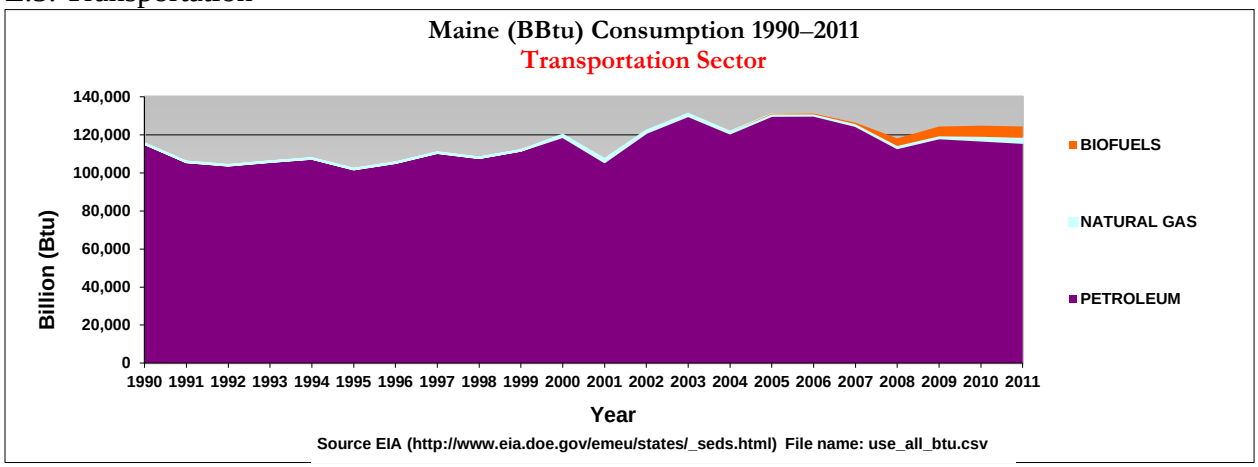


E.4. Residential



Appendix E. (continued)

E.5. Transportation



Appendix F.

Petroleum Consumption Fuel Types[6]

Billion (Btu)	1990	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011
Asphalt Road Oil	4,282	2,222	3,275	4,868	2,526	167	2,224	199	1,688	1,698	1,662
Aviation Gasoline	312	128	192	166	203	262	260	169	179	113	268
Distillate Fuel	77,654	89,221	113,472	113,814	98,871	90,929	92,510	83,607	77,459	72,996	76,220
Jet Fuel	14,015	5,148	5,228	6,169	8,081	10,149	10,008	7,946	6,976	8,719	7,325
Kerosene	3,726	10,429	8,912	11,504	11,295	8,954	6,268	2,697	3,397	3,280	2,349
Liquefied Petroleum Gas	5,238	5,039	6,990	4,747	8,855	7,977	10,677	10,512	11,739	10,859	11,463
Lubricants	1,219	1,242	1,040	1,054	1,048	1,021	1,054	979	880	978	928
Motor Gasoline	74,206	85,068	95,134	88,679	89,983	88,110	86,713	78,355	78,058	78,611	78,609
Petroleum Coke	0	837	0	0	0	0	0	0	0	0	0
Residual Fuel	66,833	59,723	31,713	29,746	43,593	28,559	25,621	19,776	22,497	15,456	13,170
Sum	47,484	259,056	265,956	260,746	264,455	236,128	235,334	204,241	202,872	192,710	191,994

[6] Source: EIA State Energy Data System (www.eia.doe.gov/emeu/states/_seds.html)

Appendix G.

Economic Analysis Input Data

Maine's Greenhouse Gas - CO_2e Emissions Economics					
YEAR	**Real GDP Millions**	**Total GHG Gross MMTCO2e**	**Total BBtu per Real GDP Millions $**	**MMTCO2e per Real GDP Millions**	**BBtu per MMTCO2**
1990	33,440	21.53	13.38	644	42.66
1991	32,462	21.10	13.92	650	41.17
1992	32,873	22.04	14.39	670	41.10
1993	33,068	21.68	14.39	656	40.02
1994	33,940	23.04	13.90	679	43.29
1995	34,800	21.86	12.87	628	42.66
1996	35,838	22.45	13.10	626	41.85
1997	37,227	22.88	12.79	615	41.83
1998	38,499	22.65	11.29	588	45.21
1999	40,105	23.75	11.13	592	46.44
2000	41,715	24.73	11.17	593	46.79
2001	42,570	24.78	9.93	582	51.71
2002	43,636	25.66	9.50	588	54.86
2003	44,224	27.58	10.36	624	53.88
2004	45,797	27.15	9.80	593	53.84
2005	45,520	26.96	10.12	592	51.80
2006	46,076	24.57	9.61	533	48.74
2007	46,168	24.31	9.54	527	48.23
2008	45,572	22.14	9.19	486	46.41
2009	44,770	21.18	9.01	473	46.36
2010	45,564	20.80	8.91	457	45.22
2011	45,763	19.92	8.79	435	42.94